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Formula Sheet

$$\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}\vec{a}t^2 \qquad \vec{v_f} = \vec{v_0} + \vec{a}t$$

$$v_f^2 = v_0^2 + 2\vec{a} \cdot \Delta\vec{r}$$

$$x = \frac{v_0^2}{g}\sin 2\theta_0 \qquad y = \frac{v_0^2}{2g}\sin^2\theta_0$$

$$y = x\tan\theta_0 - \frac{g}{2v_0^2\cos^2\theta_0}x^2$$

$$\vec{F} = m\vec{a} \qquad F = \frac{mv^2}{r}$$

$$f_k = \mu_k N \qquad f_s \leq \mu_s N$$

$$\vec{W} = m\vec{g} \qquad \vec{F} = -k\vec{x}$$

$$K = \frac{1}{2}mv^2 \qquad W = \vec{F} \cdot \Delta\vec{r}$$

$$\Delta K = W \qquad W = \int \vec{F} \cdot \Delta\vec{r}$$

$$P = \frac{dW}{dt} \qquad \vec{F} = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$$

$$U = \frac{1}{2}kx^2 \qquad U = mgh$$

$$\vec{p} = m\vec{v} \qquad \vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{r}_{cm} = \frac{\sum_i m_i\vec{r}_i}{\sum_i m_i} \qquad v_f - v_i = v_{er}\ln\frac{M_i}{M_f}$$

$$\theta(t) = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2 \qquad \omega(t) = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta \qquad W = \tau\Delta\theta$$

$$W = \int \tau\, d\theta \qquad I = \sum_i m_i r_i^2$$

$$I = \int r^2\, dm \qquad \vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$$

$$\vec{\tau} = \frac{d\vec{L}}{dt} \qquad \vec{\tau} = I\vec{\alpha}$$

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$$I_{solid-sphere} = \frac{2}{5}MR^2 \qquad I_{hollow-sphere} = \frac{2}{3}MR^2$$

$$K = \frac{1}{2}I\omega^2 \qquad K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$mv\hat{i} - Mu\hat{i} = -mv'\hat{i} + Mu'\hat{i} \qquad u' = \frac{2mv + (m-M)u}{M+m}$$

$$v' = \frac{2Mu + (M-m)v}{M+m}$$

$$\vec{F} = -\frac{GmM}{r^2}\hat{r} \qquad U = -\frac{GmM}{r}$$

$$T^2 = \frac{4\pi^2}{G(M_1+M_2)}a^3 \qquad v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$$

$$m\frac{d^2x}{dt^2} + kx = 0 \qquad x(t) = A\cos(\omega t + \phi)$$

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0 \qquad x(t) = Ae^{-bt/2m}\cos(\omega_D t + \phi)$$

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_0\cos(\omega_{drive}t) \qquad x(t) = A_{drive}\cos(\omega_{drive}t + \phi_{drive})$$

$$A_{drive} = \frac{F_0}{\sqrt{m^2(\omega_{drive}^2 - \omega_0^2)^2 + b^2\omega_{drive}^2}} \qquad \phi_{drive} = \tan^{-1}\left(\frac{b\,\omega_{drive}}{m(\omega_{drive}^2 - \omega_0^2)}\right)$$

$$\omega_D = \sqrt{\frac{k}{m} - \left(\frac{b}{2m}\right)^2}$$

Fundamental Constants

$$G = 6.673 \times 10^{-11}\,\mathrm{m^3\,kg^{-1}\,s^{-2}} \qquad c = 2.997 \times 10^8 \mathrm{m\,s^{-1}}$$

Physical Constants

$$R_e = 6.371 \times 10^6\,\mathrm{m} \qquad M_e = 5.972 \times 10^{24}\,\mathrm{kg}$$

$$g = 9.81\,\mathrm{m\,s^{-2}}$$